Half the Time: An Overview of the LBO-USNO Timeshare Agreement

Megan C. Johnson[1], Alan Fey[1], Bryan Dorland[1], Christopher Dieck[1], Nicole Geiger[1], Lucas Hunt[1,2], John Spitzak[1,3]

Abstract We present an overview of the Long Baseline Observatory (LBO) — United States Naval Observatory (USNO) 50% timeshare agreement. The USNO has contributed 50% of the operations costs to the LBO in exchange for 50% of the time on the VLBA since January 2017. The USNO uses the majority of this time allotment for observations related to Celestial and Terrestrial Reference Frame work and Earth Orientation Parameters, including maintenance and improvements in preparation for the upcoming release of the ICRF3, source structure studies, and daily Intensive and geodetic observations. In addition, USNO supports scientific research observations related to our mission objectives. Here, we present a summary of our supported projects on the VLBA and our thoughts and ideas for potential future applications of the VLBA.

Keywords VLBA, LBO, USNO

1 Introduction

The Very Long Baseline Array (VLBA) is a radio interferometer that consists of ten identical antennas, eight of which are placed across the continental United States; one antenna is located on Mauna Kea (MK) in Hawai'i, and one antenna is on St. Croix (SC) in the Virgin Islands. The array contains a maximum baseline length of 8,611 km (MK–SC), which makes it a unique and highly beneficial instrument for geodetic and astrometric observations.

1. United States Naval Observatory
2. George Mason University
3. Computational Physics Incorporated

Upon announcement by the National Science Foundation that it would be divesting in the VLBA, the National Radio Astronomical Observatory (NRAO) financially separated the VLBA from its other assets, which in turn resulted in the formation of a separate, independent management facility named the Long Baseline Observatory (LBO), whose sole purpose was to manage the VLBA. The LBO was launched on 1 October 2016 and actively sought funding partners to sustain the VLBA's scientific endeavors. Due to the unique capabilities of the VLBA and its abilities to meet mission requirements, the United States Naval Observatory (USNO) entered into a 50% timeshare agreement beginning on 1 January 2017. In exchange for 50% of the funding costs of the VLBA, the USNO is given 50% of the time on the telescope. In this paper, we provide an update of the LBO—USNO 50% timeshare agreement.

2 USNO Mission Goals and VLBA Observations

The USNO is one of the official data Analysis Centers for the International VLBI Service for Geodesy and Astrometry (IVS) and, as such, contributes data products to the VLBI community. In addition, the USNO has requirements to contribute to the maintenance and improvement of the Celestial Reference Frame (CRF), Earth Orientation Parameters (EOP), and daily measurements of UT1−UTC. Thus, long baseline radio interferometry is essential to meet our mission objectives. The USNO uses the 50% timeshare allocation on the VLBA primarily for meeting mission requirements

and uses three sets of operational observations to accomplish these goals.

The first series of observations called "daily Intensive observations" are used to measure UT1−UTC from group delay measurements on a single VLBA baseline. These data are obtained at a cadence offset from the IVS daily Intensive observation series. USNO uses the primary VLBA baseline, Mauna Kea–Pie Town (MK–PT) with backup stations St. Croix (SC) for MK and Los Alamos (LA) for PT, thus providing secondary baselines MK–LA, PT–SC, and LA–SC. During the St. Croix outage caused by hurricane Maria, USNO implemented a tertiary backup baseline utilizing the maximum continental extent of the VLBA, which is the Hancock–Owens Valley (HN–OV) baseline. These daily Intensive observations are supplemented by a second operational series called the "fortnightly observations" that are made once a fortnight, i.e., bi-weekly, for the purpose of monitoring baseline quality and stability. The fortnightly series uses all six VLBA antennas that participate in the daily Intensive observations. Finally, the third operational series that USNO supports on the VLBA is called the "RDV 24-hour EOP observations." This series is primarily for making geodetic measurements to produce state-of-the-art EOPs, but the observations have also been maximized for producing images of the sources used in all of our operational observations. The RDV experiments utilize the entire VLBA plus several other VLBI antennas for high sensitivity and good uv-coverage for imaging.

USNO also supports observations for CRF, EOP, and UT1−UTC research. A few examples of these types of observations are shown in Table 1. The project led by Dr. Aletha de Witt contributed ∼99% of the K-band CRF data for the ICRF-3 that was recently adopted by the IAU in August 2018. The S-/X-band CRF observations led by co-principal investigators Dr. David Gordon and Dr. Alan Fey improved the astrometric quality for more than 4,000 sources. These observations are also being used to produce images that will be made publicly available in the USNO Radio Reference Frame Image Database, which is currently being redesigned. The CONT17 observations are part of a large undertaking by the IVS community to produce the most accurate EOPs available. These observations occurred at the end of November 2017 and ran continuously for 15 consecutive 24-hour days.

Finally, USNO permits a small fraction of the time allocation for basic astronomical research. These observations are for USNO staff astronomers to enhance their basic scientific research programs. There are a myriad of observations that USNO has supported under this category, although the total amount of time observed for these programs constitutes less than 5% of the total observing time obtained to date.

Table 1 USNO VLBA time allocation summary from January 2017 through May 2018.

Project Name	Project Type	Total Hrs Requested	Total Hrs Observed
Daily Intensive Obs	Operational	750.75	894.27[a]
Fortnightly Obs	Operational	36	33.81
RDV 24 Hour EOP Obs	Operational	216	216
K-band CRF Obs PI: Aletha de Witt	CRF Research	624	471.63[b]
S-/X-band CRF Obs PIs: David Gordon/ Alan Fey	CRF/EOP Research	720	621.72
CONT17 PI: David Gordon	EOP Research	360	358.69
Other Astronomical Obs	Basic Research	142	104.97
Total Allotment = 3523.6 hrs	**Total Hours:**	**2848.75**	**2701.09**

Notes: [a]The additional hours observed are for testing a tertiary backup baseline, HN-OV. [b]Backlog of hours from CONT17, bad weather. In addition, May hours are not included.

3 USNO Time Allocation Process

USNO is in agreement with the LBO to not become a back door for astronomical observations that would otherwise belong under the open skies VLBA proposal mechanism. Thus, to ensure the scientific integrity of the telescope, USNO has devised an internal Telescope Allocation Committee (TAC) that meets monthly to review all proposals for time on the VLBA through the USNO 50% timeshare allocation. Figure 1 outlines the sequence for obtaining time on the VLBA through USNO. All projects that are executed through the USNO 50% timeshare allocation are required to submit an observing proposal. Proposals are due by the first of the month. The TAC meets on the third Tuesday of the month, and the outcome of the proposal is then communicated to the authors within a few days of the

TAC meeting. If the proposal is successful and time is granted, then the project is included in the observation request that is sent to the LBO on the last day of the month. The observations will be executed in the month plus one following the observation request. For example, the observation request submitted on the last day of May 2018 requests time for the month of July 2018. This gives the LBO one entire month to fold the USNO observations into their dynamical scheduling system.

The USNO TAC developed a ranking system for proposals, which gives a higher ranking to USNO mission-related projects over other types of research proposals. USNO does support external proposals that have USNO mission-related objectives like the K-band observations that are entirely externally led. For any questions about applying for time on the VLBA through the USNO 50% timeshare allocation, or to request the USNO proposal form, readers can contact the first author at megan.johnson@navy.mil.

Fig. 1 Schematic of the observing cadence for obtaining VLBA observations through the USNO 50% timeshare allocation.

4 VLBA Updates and Future Prospects

Due to the success of obtaining financial partners like USNO, the VLBA will be folded back under the NRAO umbrella later this year. This will bring a renewed stability to the future of the VLBA, which will hopefully provide a solid path to upgrading the telescope. The extent to which such an upgrade will be accomplished is not yet known; however, there are already encouraging signs that an upgrade may be possible. One such sign stems from the recent US congressional agreement to fund refurbishment to the SC station that was damaged during hurricane Maria. Under this funding provision, the SC station will be given fiber optic connections along with rust mitigation, painting of the antenna structure, and an EPA-compliant generator. With fiber optic connections enabled at the SC station, USNO looks to implement a three-station daily Intensive observation with MK, PT, and SC that will make use of the longest baseline extent of the VLBA and simultaneously mitigate the need for multiple backup baselines.

Some of the other upgrade possibilities for the VLBA include upgrading to wide bandwidth capabilities, installing new wide-band receivers, and installing fiber optic connections to all ten antennas. USNO is interested in expanding CRF research into higher frequencies as source structure is expected to be more point-like at these higher frequencies which in turn would produce a more accurate CRF. If wide bandwidth capabilities are implemented, then a set of ten new Ka-band receivers with frequency coverage from 26.5 – 40 GHz would be optimal for this area of CRF research. USNO is also interested in exploring new wide bandwidth X-band receivers similar to those currently on the Jansky VLA, possibly with a dichroic to the C-band receiver or a dichroic from the Ka-band receivers, if both are feasible to fund. Installing fiber optic links to all ten antennas is another important upgrade feature that USNO is interested in as this will enable fast data transfer rates and therefore enable correlation in a more timely manner.

5 Summary

In summary, the LBO–USNO 50% timeshare agreement has been mutually beneficial to the VLBA and the USNO. The USNO values the capabilities of the VLBA and recognizes its importance to the astrometric and geodetic community. The prospects for the future of the VLBA look promising, and we look forward to seeing what the future brings.